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Spruce Budworm Damage Survey

By

Division of Timber Management

Intermountain Region

U. S. Forest Service

1965

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Spruce Budworm Damage Survey

Introduction

A pilot damage survey was made by Region Four, Division of Timber Management, in 1964 to assess damage caused by spruce budworm. In 1965, this survey was continued and expanded on the Salmon and Challis National Forests.

Detection surveys made in the fall of 1964 indicated that nearly two million acres of timber in the Intermountain Region had spruce budworm infestations of varying severity. The heaviest infestations have been located on the upper parts of the Salmon River drainage. Spruce budworm control projects were conducted in 1954-57 and 1963-64. New insecticides to replace DDT in spruce budworm control have been studied in recent years, and several show promise.

Intensified management and use of all forest resources make it desirable to evaluate the effect of spruce budworm damage.

This survey was made in an effort to determine the kind and extent of damage caused by spruce budworm.

Objectives

The objectives of this survey were: (1) to determine effective methods for assessment of damage caused by spruce budworm and (2) to begin the evaluation of damage on a long term basis.

Methods

Location plots from the 1962 timber survey were selected for resampling. Timber survey location plots were used because they had been randomly selected and some background information was available.

All of the locations were selected within or adjacent to the current spruce budworm infestation as delineated by the detection survey made in 1964. Locations were selected to sample different exposures, elevations, drainages, and still be reasonably accessible. Plots contained all degrees of defoliation in sprayed, unsprayed, and nonspray stream protection areas. When accessible preselected plots were exhausted, similar general locations were selected before going into the field, and locations and new survey plots established.

Sampling of plots was in accordance with the grid-plot system used by the Intermountain Region Timber Survey Crews in 1962. Each location has ten 1/250 acre fixed radius plots located according to an established pattern. Variable plot trees were measured using the same plot centers. A basal area factor of 75 was used. Little difficulty was encountered in relocating the locations by using original notes, timber survey maps, and aerial photographs.

All individual trees on a fixed-radius plot were tagged with embossed plastic tape and tallied by species, d.b.h., total height, tree description class - crop, excess, mortality, or variable plot sawtimber; spruce budworm damage class--light, moderate, heavy, or severe; crown class - dominant, codominant, intermediate, or suppressed; and cause of damage; spruce budworm, other defoliator, bark beetle, mistletoe, canker, mechanical wound, or animal wound. Variable plot trees were tagged and tallied in the same manner. All trees over 5" were bored and ten year increment cores retained for later measurement.

Since there is no practical method of measuring individual tree defoliation, tree damage classes were used instead. Observations were made of gross features such as appearance of top, dead branches, and apparent defoliation. A combination of these factors determined the damage class of the tree.

A tree was not classed as dead if any green needles or live buds were found. Many trees appeared from a distance to be dead, but close examination would show some live material.

Results

1. Mortality. A total of 3,098 individual trees were recorded in the survey. Of this total, 137, or 4.4 percent, were listed as dead. Fifty trees were listed as mortality probably caused by spruce budworm. After a tree is dead a year, it is difficult to determine the true cause of death. The following table shows the size distribution of the dead trees.

Table 1 - Mortality Trees Recorded

d.b.h.	Probable Cause of Death					Total
	SBW		Other			
	Total No.	No. Per Acre	Total No.	No. Per Acre	No.	No. Per Acre
Less than 1"	36	13.6	47	17.8	83	31.4
1" - 4.9"	13	4.9	36	13.6	49	18.5
5" - 8.9"	1	.4	2	.7	3	1.1
9" +	-		2	.7	2	.7
Total	50	18.9	87	32.8	137	51.7

A very few trees died between the 1964 pilot survey and the 1965 survey. By numbering trees for a continuing survey, it will be possible to have a history of individual trees, and the cause of death can probably be determined.

From the above table, it is evident that mortality is principally in the small size classes. Part of this mortality will serve as natural thinning and may be beneficial.

2. Form Damage. Over one-third of the trees tallied had some form of damage. Dead branches were found on 14.7 percent of the total trees. This damage by itself is not significant, except as an indication that more serious damage is likely if defoliation is repeated.

Trees with dead tops were common. This is a serious type of damage. While it is not possible to assess a dollar value, nor to express a definite result of the damage, the trees are subject to rot, deformity, loss of height growth, and attack by other insects.

Top kill is not limited to small or excess trees. Dominant and codominant crop trees are affected as well as suppressed trees. Mature trees are affected along with the smaller size classes.

Some trees had extreme top defoliation, which may or may not result in dead tops. The recorded dead tops varied from dead leaders only to most of the tree crown.

Table 2

Number of Trees Damaged by Spruce Budworm on 66 Locations

Crown Class	No. Trees Recorded	Dead Top		Extreme Top Defoliation		Dead Branches		No Form Damage	
		No.	%	No.	%	No.	%	No.	%
Dominant	442	25	5.7%	6	1.4%	62	14.0%	349	78.9%
Codominant	358	24	6.7%	9	2.5%	56	15.6%	269	75.2%
Intermed., Suppress., Undetermined	2,295	434	18.9%	112	4.9%	338	14.7%	1,411	61.5%
Crop Trees	690	55	8.0%	10	1.4%	102	14.8%	523	75.8%
Excess Trees	2,405	428	17.8%	117	4.9%	354	14.7%	1,506	62.6%
Total Trees	3,095	483	15.6%	127	4.1%	456	14.7%	2,029	65.6%

3. Christmas Trees. Each year there is a demand for Christmas trees, both for commercial and personal use sales. Defoliation by spruce budworm in recent years has almost eliminated this source of income and use of a forest product. Selling Christmas trees can be a profitable method of thinning young stands and removing excess trees.

At the present time it is difficult to identify trees that were once suitable for Christmas trees, because of several years extreme defoliation. On this survey, an average of 50 Christmas trees per acre had suitable form and size, but not necessarily foliage. Approximately 68 percent of the trees that appear to have been suitable for Christmas trees are now damaged to the extent that they are no longer suitable. With an average value per tree of $1.00, this results in a potential loss of $34.00 per acre.

4. Regeneration

a. Seed Production. A fair cone crop was produced in non-infested areas of the Region in 1965. Of the 66 locations examined, 27 had no cones visible, 25 locations had a few cones present, and 14 locations had a fair or plentiful supply of current cones. A plentiful cone supply was found only in areas of practically no defoliation. Where a few cones were present, the defoliation was always less than 50 percent. Heavy defoliation apparently destroys the cone crop.

Most of the locations that were sprayed in the 1964 Spruce Budworm Control Project did produce some cones in 1965. Very few of these locations produced cones in 1964.

b. Reproduction (0 - 6" height). On eight locations no reproduction was found, nor was it expected, because of an overstocked or harsh site. On 30 locations no reproduction was found, but normally it would be expected if seed were available.

On 28 locations some reproduction was found. These areas where reproduction was found were generally areas of light or recent infestation.

The above information again points out that we do not get Douglas-fir reproduction if there is continued spruce budworm defoliation in the Intermountain Region.

5. Multiple Use Values. Each location was again evaluated for the probable effect of the spruce budworm infestation upon resources other than timber. An actual measurement of these effects is not possible. Each location was evaluated for watershed, fire, range, wildlife, fisheries, and recreation as desirable, harmful, or no impact caused by spruce budworm.

a. Watershed. Present damage levels gave no indication of any effect on the watershed. If the timber is heavily defoliated over large areas for several years, ground cover consisting of fallen needles would be lost and it could effect watershed values. This condition was not observed.

b. Fire. Any defoliation tends to open up the timber stand and enable faster drying of fuels. This increases the hazard of a fire starting, permits faster spread, and increases the intensity of a fire.

Mortality of larger trees would result in more snags. Snags are a cause of lightning fires and make fire suppression more difficult.

Defoliation causes a slight reduction in the fuel supply. Much of the new foliage is either eaten by the budworm or dies and soon falls to the ground and decomposes.

Conditions varied from no apparent effect to heavy defoliation of small areas with considerable opening effect. The fire hazard resulting from the effects of spruce budworm varied from negligible to a noticeable increase on small areas.

c. Range. Five locations showed desirable effects for range management. These were a result of opening up of the timber stand allowing more forage production. This effect is probably not desirable for the area when all resource values are considered.

d. Wildlife. Harmful effects for wildlife can be caused by severe defoliation. The result is loss of cover for shading up and concealment. Two locations showed this undesirable effect.

The desirable effects are thinning of dense thickets enabling passage and opening a timber stand to allow more browse production. Seven locations showed this desirable effect for wildlife.

e. Fisheries. No location showed any noticeable direct effect upon fisheries.

f. Recreation. Eleven locations showed harmful effects. This was a result of loss of cover in areas used for camping or picnicking, or the aesthetic loss of an entire hillside facing heavy recreation use areas being defoliated.

The aesthetics of the entire infestation area are adversely effected by the unhealthy appearance of the timber stand.

Most of the locations examined were in the Intermediate Multiple Use Zone. Ten locations were in the Travel Influence Zone, where aesthetic values assumed greater importance. The same would be true in the Water Influence Zone. No locations were in the Crest Zone or the Lower Zone, nor is a spruce budworm infestation likely. Climatic conditions in these zones are unsuitable for spruce budworm.

6. Increment Loss. Increment cores were collected from all trees over five inches d.b.h. Increment for the previous ten years was determined by microscopic examination of a sample of size classes from each location.

The volume increment per tree as computed from d.b.h., total height, and ten year increment measurement was generally higher for the undamaged and light damage trees than it was for medium, heavy, and extreme damage trees.

The volume of increment loss due to spruce budworm cannot be determined at this time. The job of making a complete analysis of increment loss appears to be a research project by itself. Many factors other than spruce budworm cause growth differences in each tree.

The increment cores collected in 1965 are available for further study.

The decline in spruce budworm populations caused by the 1964 control project and the 1966 natural control may present an opportunity for better interpretation of future core samples.

7. Areas of Apparent Heavy Mortality. Some of the survey locations were within areas that appeared from a distance to have considerable mortality.

These locations were sampled the same as other areas. There was a small amount of actual mortality in the smaller size classes of trees. Most of the trees that appeared from a distance to be dead were extremely defoliated trees that were still living.

Future surveys will determine the extent of recovery or loss of these heavily defoliated trees.

On one such location that was sampled in 1964, two trees had died during 1965.

Discussion

Douglas-fir is the principal species affected by spruce budworm. Defoliation is also found in subalpine fir and Engelmann spruce, but generally defoliation in these species is a minor consideration.

Most of the Douglas-fir type on the Salmon National Forest and much of this type on the Challis National Forest has spruce budworm. The infestation is very irregular with heavy, moderate, and light damage intermingled. The detection surveys average these conditions. The younger age classes of trees are affected more than mature trees. Since most

of the infested timber stands have mixed age classes, the defoliated areas have a spotted appearance with only part of the stand showing serious effects of defoliation.

The 1964 spray area still has budworm, but in extremely low numbers. A very low percentage of defoliation or new damage was found.

It appeared that, generally, the stream protection zones left by the 1964 spraying also had few budworm. A very few nonspray areas still had sizeable budworm populations.

A few areas such as Porphyry Creek and Indian Creek appeared from a distance to have current defoliation. Close examination showed the cause to be discoloration by a heavy spider mite infestation. Spider mite infestations have been common following DDT control operations, but have usually been short lived.

The year 1965 had above-normal rainfall and cool temperatures. This gave good foliage growth. The defoliation damage does not show up as prominently during such a year.

Once permanent plots are established, it will not be necessary to remeasure the plots each year. The plots could be remeasured at intervals of up to five years and a background of information would still be available. When there is heavy defoliation, or a sudden collapse of infestation as appears likely in 1966, the remeasurement intervals should be shortened to permit assessment of damage condition changes.

The survey plots that are included with control project areas will serve as a valuable means of assessing long-term effects of the control project.

In order to assess damages, it is desirable to build up a history of a particular area. A sample of individual tree histories is essential to an assessment of the area. The damage survey can be used to record the history of individual trees on the area.

Establishment of plots or relocating suitable timber survey plots should be considered in all spruce budworm infestation areas such as the Targhee and Sawtooth National Forests. Additional plots will be needed on the Challis National Forest. Some of the Salmon National Forest plots may not be considered necessary.

The damage survey should not be considered as a one-shot answer to what and how much the damage is. It should be used as a tool to assess the extent of damages. As we build up an inventory of knowledge about timber stands that are subject to spruce budworm infestations, we can make better assessments of damage values.

Spruce budworm in the Intermountain Region is not a quick killer as is the bark beetle, but rather a slow, steady source of damage that can eventually cause tree mortality. Apparently the mixed age classes and intermixed species and types do not favor the extensive and rapid kills that are common in the east, in Canada, and to a lesser extent in Montana.

In the Intermountain Region we have not had continued, intensive, uncontrolled epidemics of spruce budworm to find out how much mortality will result. We have had either control projects or natural control such as appears likely in 1966 before the infestation causes extensive mortality.

An existing timber survey ADP program was adapted to permit compilation of data collected. Further assessment is needed to evaluate information needed for and from future programs.

Recommendations

1. Continue damage survey. It is not always necessary to remeasure each year. The interval between measurements would depend upon intensity or changes in spruce budworm populations.

2. Make a continuing record of damage effects and correlate with defoliation intensity. Build up a history of all existing infestation areas.

3. Permanently establish survey locations and tag the individual trees.

4. Maintain existing methods and data until an evaluation shows more or less information is needed to justify control or not to control.

5. Study ADP program and results to best utilize ADP in getting desired information compiled.

6. Continue to survey all forest conditions. Do not change survey so that it is measuring only the entomological aspects. Conditions caused by the insects are the reason for control.

7. Continue efforts to correlate increment loss with damage conditions. This may require a separate research project. Utilize existing cores.

8. Continue to evaluate and study the entire problem.

Locations Sampled 1965

Location ADP Number (Tag Number) Drainage	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
901 (S1) Fourth of July Cr.	Salmon	5,200	5 ±	-(SP)	4	0	few	T	0	-	0	0	-
902 (S2) Iron Cr.	Salmon	6,100	5 ±	'65	3	0	0	I	0	0	0	0	0
903 (S3) Gilmore	Salmon	7,300	1	-	1	few	yes	T	0	0	0	0	0
904 (S4) Fourth of July Cr.	Salmon	6,300	5 ±	-(SP)	3	0	yes	T	0	-	0	+	-
905 (S15A) Boogerville	Salmon	6,200	5 ±	-	2	few	yes	I	0	0	0	0	0
909 (S9) Kadlitz Cr.	Salmon	6,900	5 ±	-	3	0	0	I	0	0	+	+	-
911 (S11) Silver Cr.	Salmon	5,500	5 ±	-(SP)	4	0	0	I	0	-	0	-	-
912 (S12) Nigger Cr.	Salmon	6,400	3-5	-	4	0	0	I	0	-	0	0	-
915 (S15B) Lake Cr.	Salmon	6,300	5 ±	-(SP)	1	few	0	I	0	-	0	-	-
916 (S16) Wallace Lake	Salmon	5,700	5 ±	-	2	0	yes	T	0	0	0	0	0

_/ Footnotes listed on page 16.

Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreati
917 (S17) Leesburg	Salmon	6,600	5 ±	-	4	0	0	I	0	0	0	0	0
918 (S18) Sawmill Gulch	Salmon	7,200	5 ±	-	2	0	0	I	0	0	0	0	0
920 (S20) Benson Ranch	Salmon	6,800	5 ±	-	3	0	0	I	0	0	+	+	-
921 (S21) Mill Cr.	Salmon	?	5 ±	-	2	0	few	I	0	0	0	0	0
922 (S22) Hayden Cr.	Salmon	6,200	5 ±	-	3	0	0	I	0	0	+	+	-
005 Iron Cr.	Salmon	6,700	5 ±	'65	3	0	0	I	0	0	0	0	0
012 Head Iron Cr.	Salmon	8,400	0	-	0	many	many	I	0	0	0	0	0
013 Iron Cr.	Salmon	7,200	5 ±	-	1	0	0	I	0	0	0	0	0
021 Lake Cr. Williams Lake	Salmon	6,000	5 ±	-	1	0	0	I	0	0	0	0	0
024 Boogerville	Salmon	6,800	5 ±	-	1	few	0	I	0	0	0	0	0
025 Moore Cr.	Salmon	5,900	5 ±	-	2	0	0	I	0	0	0	0	0

/ Footnotes listed on page 16.

Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
027 Williams Cr.	Salmon	6,000	5 ±	-	0	few	-	I	0	0	0	0	0
028 Carmen Road	Salmon	5,900	5 ±	-	3	few	0	I	0	0	0	0	0
037 Haynes Cr.	Salmon	7,000	5 ±	-	3	0	few	I	0	-	+	+	0
053 Long Tom	Salmon	6,000	-1	'64	0	many	0	I	0	0	0	0	0
074 Spring Cr.	Salmon	5,100	5 ±	-(SP)	0	few	0	I	0	-	0	0	0
093 Indian Cr.	Salmon	6,200	-1	'64	0	few	0	I	0	0	0	0	0
099 Hayden Cr.	Salmon	7,600	5 ±	-	3	0	0	I	0	0	+	0	0
101 Sawmill Cr.	Salmon	7,600	5 ±	-	3	0	0	I	0	0	0	0	0
111 Agency Cr.	Salmon	7,100	5 ±	-	3	0	few	I	0	0	0	0	0
118 Cruckshank Cr.	Salmon	8,400	-	-	-	many	few	I	0	0	0	0	0
119 Frank Hall Cr.	Salmon	7,800	2	-	0	many	many	I	0	0	0	0	0

/ Footnotes listed on page 16.

Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
123 W. Fk. Hughes Cr.	Salmon	5,300	-2	63-64	0	few	many	T	0	0	0	0	0
124 Hull Cr.	Salmon	5,700	-1	'64	0	0	0	I	0	0	0	0	0
125 Hull Cr.	Salmon	5,700	-1	'64	0	0	-	I	0	0	0	0	0
128 Ditch Cr.	Salmon	6,500	-2	63-64	0	few	0	I	0	0	0	0	0
129 Hull Cr.	Salmon	4,500	-1	'64	0	few	few	I	0	0	0	0	0
130 N. Fk. Salmon	Salmon	5,500	5 ±	-(SP)	0	many	few	T	0	0	0	0	0
133 N. Fk. Salmon	Salmon	5,000	5 ±	_(SP)	0	many	few	I	0	0	0	0	0
136 Sheep Cr.	Salmon	5,500	-1	'64	0	few	few	I	0	0	0	0	0
137 Stein Gulch	Salmon	4,700	-1	'64	0	few	0	I	0	0	0	0	0
141 Lick Cr.	Salmon	6,600	-1	'64	0	few	0	I	0	0	0	0	0
154 Lake Cr.	Salmon	6,300	5 ±	-(SP)	2	few	0	I	0	-	0	0	-

1/ Footnotes listed on page 16.

Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
175 Silver Cr.	Salmon	6,700	5 ±	-(SP)	4	0	0	I	0	-	0	0	0
180 Porphyry Cr.	Salmon	7,800	-1	'64	0	few	few	I	0	0	0	0	0
191 Blackbird Cr.	Salmon	7,200	-1	'64	0	many	many	I	0	0	0	0	0
198 Musgrove Cr.	Salmon	5,800	5 ±	-(SP)	0	few	few	I	0	+	0	+	-
200 Panther Cr.	Salmon	6,500	5 ±	-(SP)	0	few	few	T	0	0	0	0	0
201 Jureano LD	Salmon	7,000	-1	'64	1	few	-	I	0	0	0	0	0
203 Panther Cr.	Salmon	5,800	5 ±	-(SP)	1	o	0	T	0	0	0	0	0
207 Jureano LD	Salmon	7,200	-1	'64	0	many	few	I	0	0	0	0	0
210 Cobalt	Salmon	5,200	5 ±	-(SP)	0	few	0	T	0	0	0	0	0
217 Copper Cr.	Salmon	5,200	5 ±	-(SP)	0	0	0	T	0	0	0	0	0
220 Mocasin Cr.	Salmon	6,400	-1	'64	0	few	few	I	0	0	0	0	0

1/ Footnotes listed on page 16.

Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
801 Bald Mountain	Salmon	7,500	0	-	0	many	-	I	0	0	0	0	0
056 Seafoam	Challis	6,900	3-5	-	0	few	few	I	0	0	0	+	0
060 Seafoam	Challis	6,800	3-5	-	0	many	0	I	0	0	0	0	0
066 Drop Cr.	Challis	7,200	3-5	-	0	many	few	I	0	0	0	0	0
138 Mosquito Flat	Challis	7,400	3-5	-	1	many	few	I	0	0	0	0	0
141 Spruce Gulch	Challis	7,300	3-5	-	0	few	few	I	0	0	0	0	0
147 Jeff Cr.	Challis	8,600	3-5	-	0	many	-	I	0	0	0	0	0
150 Lick Cr.	Challis	7,900	3-5	-	0	few	few	I	0	0	0	0	0
151 W. Fk. Morgan	Challis	7,300	3-5	-	1	few	few	I	0	0	0	0	0
152 Van Horn Cr.	Challis	7,400	3-5	-	2	0	0	I	0	0	0	0	0
153 Sawmill Cr.	Challis	7,100	3-5	-	3	0	0	I	0	-	0	0	0

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Location	Forest	Elev.	Estimated Years Infest.	1/ Year Spray	2/ Stand Defol. Class	Cones	3/ Reprod.	4/ MU Zone	5/ Watershed	5/ Fire	5/ Range	5/ Wildlife	5/ Recreation
604	Challis	6,200	3-5	-	0	many	-	I	0	0	0	0	0

1/ (SP) = 1964 Stream Protection

2/ 1 = light 3 = Heavy
2 = medium 4 = Extreme

3/ - = None likely

4/ I = Intermediate T = Travel Influence

5/ 0 = No influence
- = Harmful
+ = Desirable

1965 SBW Damage Survey

Challis N.F. 11 Locations 327,000 acres Unsprayed

Species	Damage Class	Number of Trees per Acre 0-4"	5"-8"	9"+	No. Trees/A Total	Vol./Acre BF-Scribner 9"+	10 yr. Increase Vol./Acre BF-9"+	Vol/Acre Cu. Ft. 5"-8"	Vol/Acre Cu. Ft. 9"+	Vol./Acre Cu. Ft. Total	10 yr. Increase Vol./Acre Cu. Ft.	TOTAL VOLUME for Area M.B.F.	M.Cu. Ft.
19 A.F.	Undamaged	31.82	—	—	31.82								
	Light	4.55	—	1.03	5.58	76.69	13.29		17.51	17.51	2.41	25077.1	5726.0
		36.36	—	1.03	37.40	76.69	13.29	—	17.51	17.51	2.41	25077.1	5726.0
93 E.S.	Undamaged	—	—	1.05	1.05	79.46	17.07	—	17.63	17.63	3.18	25982.6	5963.8
	Light	—	1.58	—	1.58	—	—	14.13	—	14.13	5.28	—	4621.7
		—	1.58	1.05	2.63	79.46	17.07	14.13	17.63	31.76	8.46	25982.6	10385.5
101 WLP	Undamaged	—	1.86	.87	2.73	23.18	7.13	15.77	6.44	22.21	3.85	7581.0	7262.0
		—	1.86	.87	2.73	23.18	7.13	15.77	6.44	22.21	3.85	7581.0	7262.0
108 LPP	Undamaged	38.64	17.53	—	56.16	—	—	81.71	—	81.71	9.21	—	26717.9
		38.64	17.53	—	56.16	—	—	81.71	—	81.71	9.21	—	26717.9
122 PP													
202 DF	Undamaged	29.55	60.16	37.90	127.61	4641.36	1148.45	216.10	999.50	1215.60	233.96	1517725.5	347502.0
	Light	84.09	43.94	22.89	150.92	3189.55	621.38	116.44	665.87	782.31	144.43	1042983.1	255815.0
	Medium	72.73	31.76	13.17	117.66	809.93	87.88	91.54	208.43	299.97	36.14	264848.1	98091.2
	Heavy	9.09	1.58	.84	11.51	47.69	6.51	14.04	12.61	26.65	2.27	15593.1	8713.3
	Extreme	2.27	—	—	2.27	—	—	—	—	—	—	—	—
	Mortality	—	—	—	—	—	—	—	—	—	—	—	—
		197.73	137.44	74.80	409.97	8688.53	1864.22	438.12	1886.41	2324.53	416.80	2841149.5	760121.3
	All Species Undamaged	100.01	79.55	39.82	219.37	4744.00	1172.65	313.58	1023.57	1337.14	250.20	1551289.1	437245.7
	Light	88.64	45.52	23.92	158.08	3266.24	634.67	130.57	683.38	813.95	152.11	1068060.1	266162.7
	Medium	72.73	31.76	13.17	117.66	809.93	87.88	91.54	208.43	299.97	36.14	264848.1	98091.2
	Heavy	9.09	1.58	.84	11.51	47.69	6.51	14.04	12.61	26.65	2.27	15593.1	8713.3
	Extreme	2.27	—	—	2.27	—	—	—	—	—	—	—	—
	Mortality	—	—	—	—	—	—	—	—	—	—	—	—
	Total	272.74	158.41	77.75	508.89	8867.86	1901.71	549.73	1927.99	2477.71	440.72	2899790.2	810212.7
DF	Total Annual Increment											60960	13629
All Sp.	" " "											62186	14412

1965 SBW Damage Survey

Salmon N.F. 24 Locations 180,000 acres Unsprayed

Species	Damage Class	Number of trees per Acre 0-4"	5"-8"	9"+	No. Trees/A Total	Vol./Acre B.F. Scribner 9"+	10 Yr. Incre. Vol./Acre B.F. 9"+	Vol./Acre Cu. Ft. 5"-8"	Vol./Acre Cu. Ft. 9"+	Vol./Acre Cu. Ft. Total	10 Yr. Incre. Vol./Acre Cu. Ft.	Total Volume Area MBF	M. Cu. Ft.
19	AF Undamaged	26.04	17.96	—	44.01	—	—	60.21	—	60.21	36.14	—	10838.0
		26.04	17.96	—	44.01	—	—	60.21	—	60.21	36.14	—	10838.0
93	ES Undamaged	8.33	.87	—	9.21	—	—	6.18	—	6.18	.37	—	1112.8
	Heavy	—	1.59	—	1.59	—	—	4.44	—	4.44	1.34	—	799.6
		8.33	2.46	—	10.80	—	—	10.62	—	10.62	1.72	—	1912.4
101	WLP Undamaged	13.54	4.82	1.30	19.67	37.91	21.97	20.90	10.24	31.14	7.08	6823.3	5604.5
		13.54	4.82	1.30	19.67	37.91	21.97	20.90	10.24	31.14	7.08	6823.3	5604.5
108	LPP Undamaged	13.54	2.71	1.51	17.76	107.52	66.17	15.52	23.50	39.01	10.64	19353.0	7022.5
	Light	2.08	4.77	—	6.85	—	—	24.90	—	24.90	6.77	—	4481.5
		15.63	7.48	1.51	24.62	107.52	66.17	40.42	23.50	63.91	17.41	19353.0	11504.0
122	PP Light	—	—	.20	.20	27.98	15.43	—	6.07	6.07	2.61	5036.9	1093.1
		—	—	.20	.20	27.98	15.43	—	6.07	6.07	2.61	5036.9	1093.1
202	DF Undamaged	12.50	8.05	3.37	23.92	244.97	167.95	25.55	60.17	85.71	48.97	44094.9	15428.0
	Light	21.87	12.34	14.56	48.77	1625.13	783.76	54.14	357.88	412.02	163.99	292523.3	74164.2
	Medium	16.67	18.43	11.48	46.58	1146.22	308.37	55.38	258.53	313.90	73.50	206319.6	56502.5
	Heavy	59.37	25.45	12.65	97.47	1727.67	408.63	74.76	365.10	439.86	92.41	310979.9	79174.0
	Extreme	33.33	1.20	3.68	38.22	566.53	114.37	8.19	134.85	143.04	23.60	101975.9	25747.9
	Mortality	1.04	—	.43	1.47	67.53	—	—	13.81	13.81	—	12155.8	2486.2
		144.79	65.47	46.17	256.43	5378.05	1783.09	218.02	1190.33	1408.35	402.46	968049.3	253502.8
	All Species Undamaged	73.95	34.41	6.18	114.57	390.40	256.09	128.36	93.91	222.25	103.20	70271.1	40005.8
	Light	23.95	17.11	14.76	55.82	1653.11	799.19	79.04	363.95	442.99	173.37	297560.3	79738.8
	Medium	16.67	18.43	11.48	46.58	1146.22	308.37	55.38	258.53	313.90	73.50	206319.6	56502.5
	Heavy	59.37	27.04	12.65	99.06	1727.67	408.63	79.20	365.10	444.30	93.75	310979.9	79973.6
	Extreme	33.33	1.20	3.68	38.22	566.53	114.37	8.19	134.85	143.04	23.60	101975.9	25747.9
	Mortality	1.04	—	.43	1.47	67.53	—	—	13.81	13.81	—	12155.8	2486.2
	Total	208.33	98.19	49.18	355.72	5551.46	1886.66	350.17	1230.14	1580.30	467.41	999625	284454.8
DF	Total Annual Increment											32096	7244
All Sp.	" " "											33960	8413

1965 SBW Damage Survey

Salmon N.F. 15 Locations 41,000 acres — No Spray (Protection)

Species		Damage Class	Number of Trees per Acre 0-4"	5"-8"	9"+	No. Trees/A. Total	Vol./Acre B.F. Scribner 9"+	10 Yr. Incre. Vol./Acre B.F.	Vol./Acre Cu. Ft. 5"-8"	Vol./Acre Cu. Ft. 9"+	Vol./Acre Cu. Ft. Total	10 Yr. Incre. Vol./Acre Cu. Ft.	Total for Area MBF	Volume M. Cu. Ft.
19	AF	Undamaged	1.67	4.86	.95	7.48	55.85	14.10	21.13	13.46	34.60	15.70	2289.7	1418.4
		Light	21.67	5.78	—	27.44	—	—	21.45	—	21.45	11.65	—	879.6
		Medium	5.00	—	—	5.00	—	—	—	—	—	—	—	—
		Heavy	—	2.55	—	2.55	—	—	11.24	—	11.24	1.15	—	460.8
		Extreme	—	—	.99	.99	97.80	12.27	—	24.69	24.69	2.22	4009.8	1012.4
			28.33	13.18	1.95	43.46	153.65	26.37	53.83	38.15	91.98	30.72	6299.5	3771.2
93	ES	Heavy	—	—	.97	.97	46.39	10.69	—	11.26	11.26	1.99	1901.8	461.6
			—	—	.97	.97	46.39	10.69	—	11.26	11.26	1.99	1901.8	461.6
101	WLP		—	—	—	—	—	—	—	—	—	—	—	—
108	LPP	Undamaged	50.00	30.31	2.60	82.91	210.45	135.24	164.59	45.08	209.66	73.45	8628.3	8596.2
		Mortality	1.67	—	—	1.67	—	—	—	—	—	—	—	—
			51.67	30.31	2.60	84.57	210.45	135.24	164.59	45.08	209.66	73.45	8628.3	8596.2
122	PP	Undamaged	1.67	3.47	2.35	7.49	838.88	265.16	15.28	157.84	173.11	55.67	34394.2	7097.7
			1.67	3.47	2.35	7.49	838.88	265.16	15.28	157.84	173.11	55.67	34394.2	7097.7
202	DF	Undamaged	91.67	22.69	11.17	125.52	1339.40	285.28	78.78	292.27	371.04	96.82	54915.6	15212.7
		Light	51.67	15.17	12.71	79.55	1923.58	607.04	49.06	400.27	449.33	129.69	78867.0	18422.5
		Medium	3.33	8.65	5.51	17.50	457.97	102.49	22.22	106.84	129.06	20.81	18776.7	5291.4
		Heavy	13.33	1.30	4.63	19.26	593.55	103.99	8.73	126.36	135.09	18.30	24335.6	5538.6
		Extreme	48.33	13.41	8.29	70.03	1150.51	87.72	79.93	286.93	366.86	25.51	47170.8	15041.4
		Mortality	13.33	2.55	0.58	16.46	132.86	—	9.11	26.49	35.60	—	5447.3	1459.7
			221.67	63.76	42.89	328.32	5597.88	1186.53	247.82	1239.17	1486.98	291.13	229512.9	69966.3
		All Species Undamaged	145.01	61.33	17.07	223.40	2444.58	699.78	279.78	508.65	788.42	241.64	100227.7	32325.0
		Light	73.34	20.95	12.71	106.99	1923.58	607.04	70.51	400.27	470.78	141.34	78867.0	19302.1
		Medium	8.33	8.65	5.51	22.50	457.97	102.49	22.22	106.84	129.06	20.81	18776.7	5291.4
		Heavy	13.33	3.85	5.60	22.79	639.94	114.68	19.97	137.62	157.59	21.44	26237.4	6461.0
		Extreme	48.33	13.41	9.28	71.03	1248.31	99.99	79.93	311.62	391.55	27.73	51180.7	16053.7
		Mortality	15.00	2.55	0.58	18.12	132.86	—	9.11	26.49	35.60	—	5447.3	1459.7
		Total	303.34	110.74	50.75	464.82	6847.24	1623.99	481.52	1491.50	1973.00	452.96	280736.8	80893.0
		DF Total Annual Increment											4865	1194
		All Sp. " " "											6659	1857

1965 SBW mage Survey

Salmon N.F. 16 Locations 350,000 acres Sprayed

Species	Damage Class	Number of Trees per Acre 0-4"	5-8"	9"+	No Trees/A Total	Vol/Acre BF Scribner 9"+	10 Yr. Incre. Vol./Acre B.F. 9"+	Vol/Acre Cu. Ft. 5-8"	Vol/Acre Cu. Ft. 9"+	Vol./Acre Cu. Ft. Total	10 Yr. Incre. Vol./Acre Cu. Ft.	Total for Area MBF	Volume M. Cu. Ft.
19 AF	Undamaged	1.56	—	.70	2.26	58.08	24.85	—	12.96	12.96	4.50	20328.6	4537.3
		1.56	—	.70	2.26	58.08	24.85	—	12.96	12.96	4.50	20328.6	4537.3
93 E.S.	Undamaged	6.25	4.26	2.98	13.49	431.75	68.70	19.88	88.43	108.31	15.41	151113.1	37908.1
		6.25	4.26	2.98	13.49	431.75	68.70	19.88	88.43	108.31	15.41	151113.1	37908.1
101 WLP		—	—	—	—	—	—	—	—	—	—	—	—
108 LPP	Undamaged	17.19	38.73	—	55.91	—	—	185.09	—	185.09	75.19	—	64781.6
	Light	3.13	7.76	—	10.89	—	—	36.85	—	36.85	17.13	—	12895.9
	Medium	1.56	—	—	1.56	—	—	—	—	—	—	—	—
		21.88	46.49	—	68.36	—	—	221.94	—	221.94	92.32	—	77677.5
122 PP	Undamaged	6.25	2.42	1.68	10.35	857.42	387.33	6.46	164.60	171.06	60.51	300097.3	59869.8
	Light	1.56	—	—	1.56	—	—	—	—	—	—	—	—
		7.81	2.42	1.68	11.91	857.42	387.33	6.46	164.60	171.06	60.51	300097.3	59869.8
202 D.F.	Undamaged	39.06	18.52	6.03	63.61	1200.66	152.57	85.81	238.43	324.24	45.58	420231.4	113483.0
	Light	223.44	71.58	17.81	312.82	2862.56	537.11	212.56	588.45	801.02	210.28	1001896.1	280355.8
	Medium	3.13	4.37	.34	7.83	213.12	18.17	11.85	37.92	49.78	9.08	74593.6	17421.5
	Heavy	4.69	—	6.54	11.23	1031.01	270.02	—	212.65	212.65	46.35	360853.3	74429.1
	Extreme	3.13	3.76	.91	7.80	60.61	8.64	24.71	19.77	44.47	2.93	21214.4	15566.1
	Mortality	23.44	—	—	23.44	—	—	—	—	—	—	—	—
		296.88	98.24	31.62	426.74	5367.97	986.50	334.93	1097.23	1432.16	314.23	1878788.7	501255.4
	All Species Undamaged	70.31	63.93	11.39	145.62	2547.92	633.45	297.24	504.42	801.66	201.19	891770.4	280579.8
	Light	228.13	79.34	17.81	325.27	2862.56	537.11	249.41	588.45	837.86	227.41	1001896.1	293251.7
	Medium	4.69	4.37	.34	9.40	213.12	18.17	11.85	37.92	49.78	9.08	74593.6	17421.5
	Heavy	4.69	—	6.54	11.23	1031.01	270.02	—	212.65	212.65	46.35	360853.3	74429.1
	Extreme	3.13	3.76	.91	7.80	60.61	8.64	24.71	19.77	44.47	2.93	21214.4	15566.1
	Mortality	23.44	—	—	23.44	—	—	—	—	—	—	—	—
	Total	334.39	151.40	36.99	522.76	6715.22	1467.39	583.21	1363.22	1946.42	486.91	2350327.6	681248.1
DF	Total Annual Increment											34528	10998
All Sp.	" " "											51359	17044